REVIEW

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The role of carbohydrate drinks in pre-operative nutrition for elective colorectal surgery

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ABSTRACT

INTRODUCTION Traditionally, patients have been fasted from midnight on the night before elective surgery. With the advent of the enhanced recovery programme for elective colorectal surgery, there has been a major change in established practice with patients able to continue with clear fluids up to two hours prior to surgery and solids up to six hours prior to surgery. It has been suggested that nutritional supplements in the immediate pre-operative period enhance post-operative recovery. The aim of this review was therefore critically to appraise the evidence available regarding the use of pre-operative carbohydrate (CHO) supplements for elective colorectal surgery.

METHODS A literature search was performed using: PubMed, MEDLINE®, Athens and Google Scholar. The following keywords were used: 'pre-operative', 'carbohydrate supplements', 'enhanced recovery' and 'colorectal surgery', singly or in combination. To ensure an up-to-date literature search, the search was restricted to the last ten years. To maximise the search, backward chaining of reference lists from retrieved papers was also undertaken. Only English language articles were included.

CONCLUSIONS The use of CHO drinks pre-operatively in colorectal surgery is both safe and effective. There is no increased risk of aspiration and it results in a shorter hospital stay, a quicker return of bowel function and less loss of muscle mass. On the basis of this evidence, the use of pre-operative CHO drinks should be standard in elective colorectal patients. Further research is nevertheless required for those with diabetes mellitus.

KEYWORDS

Colorectal surgery – Preoperative carbohydrate nutrition

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Traditionally, patients have fasted from midnight before elective surgery. This ensures an empty stomach, thereby helping protective laryngeal reflexes and reducing complications such as aspiration pneumonia. Enhanced recovery for elective colorectal surgery permits clear fluids and solids two and six hours respectively prior to surgery. Nutritional supplements pre-operatively are safe and alter the immune and catabolic response to surgery, enhancing post-operative recovery.[1–4]

Fasting depletes glycogen stores, increasing the demand for amino acids. The endocrine response of insulin resistance to fasting is central to the catabolic surgical response, resulting in reduced insulin stimulated glucose uptake in skeletal muscle and adipose tissue, increased glucose release and hyperglycaemia. Hyperglycaemia is associated with more post-operative complications. Pre-operative carbohydrate (CHO) drinks may reduce insulin resistance by maintaining and improving whole-body protein balance and muscle function.

This review aimed critically to appraise the evidence available regarding the use of pre-operative CHO supplements for elective colorectal surgery.

Methods

A literature search was undertaken using PubMed, MEDLINE®, Athens and Google Scholar. The following keywords were used: 'pre-operative', 'carbohydrate supplements', 'enhanced recovery' and 'colorectal surgery', singly or in combination. Twenty papers were found but only eleven were reviewed. Nine were excluded as they described studies involving nutritional supplements rather than carbohydrates specifically. The search was limited to English language papers but not restricted according to study type. To ensure an up-to-date literature search, it was restricted to the last ten years, with backward chaining of reference lists from retrieved papers.

Discussion

Safety of pre-operative nutritional supplements

Enhanced recovery has revolutionised colorectal surgery. Initially, concern was expressed regarding the safety of CHO supplements, which Yagci *et al* evaluated.[5] This was a randomised controlled trial (RCT) of 70 patients either undergoing a cholecystectomy or thyroidectomy. Pre-oper-

ative CHO drinks did not alter the amount or pH of gastric contents and there was no increased risk of aspiration. Although colorectal patients were not included, it established the principles of the pre-operative physiological changes.

Patient tolerance

While pre-operative nutritional supplements are safe if used correctly, this still depends on patient compliance. Yuill *et al* assessed patient tolerance and the post-operative metabolic and clinical responses.[6] This was a prospective RCT in which the control group received a placebo and the study group received an 800ml CHO drink on the preceding evening and a 400ml drink 2–3 hours prior to surgery. All participants had a nutritional assessment pre-operatively, post-operatively and at discharge. Blood glucose and insulin concentration were recorded pre-operatively and at day 1 post-operatively.

There were 34 patients randomised to the control group and 31 to the CHO group. Endogenous fat reserves were similar for both groups while the CHO group had less loss of muscle mass (-0.5cm vs -1.1cm, $p<0.05$). Post-operative findings included insulin of 9.7 units in the control group compared with 17.4 units in the CHO group and glucose of 6.2 units in the control group compared with 6.8 units in the CHO group. The CHO group had a lower average hospital stay (8 days vs 10 days) and the same rate of complications as the control group. This study highlighted that patients cooperated with the use of pre-operative CHO drinks. Their use was safe and attenuated post-operative muscle depletion.

Hendry *et al* assessed the ability to prescribe and dispense as well as patient compliance when combining pre-operative oral nutritional supplements and CHO loading during mechanical bowel preparation (MBP) prior to elective colorectal resection.[7] A total of 124 patients were included and prescribed pre-operative MBP, with 200ml oral nutritional supplements prior to each of the two sachets of sodium picosulfate followed by 400–800ml of oral 12.5% CHO fluid on the pre-operative evening and 400ml 2–3 hours before surgery. Fourteen patients failed the protocol as eight were not prescribed and six were not dispensed. However, 99 completed the regime with no adverse effects. Thus, 84% of elective colonic patients tolerated pre-operative oral fluids with MBP. Unfortunately, the quality of this evidence is decreased by interaction of the CHO drink and MBP as a confounder.

Clinical implications

Noblett *et al* assessed the effect of pre-operative oral CHO supplementation on outcome following elective colorectal resection.[8] This prospective RCT of 36 patients was divided into three equal groups: the first group had 800ml of water the night before surgery and 400ml three hours prior to anaesthesia, the second group had 100g Precarb® (Vitaflo International Ltd, Liverpool, UK) in 800ml of water the night before surgery and 50g Vitajoule® (Vitaflo International Ltd) in 400ml of water three hours before surgery and the third group were fasted from midnight before surgery. The median hospital stay for those who received CHO drinks was 7.5 days and they had their first bowel motion after 2 days while those who fasted had a median stay of 13 days and their first bowel motion at day 5, suggesting CHO drinks reduce hospital stay and hasten a return of gastrointestinal function.

Mathur *et al* also assessed the effect of oral CHO treatment on clinical outcome following major abdominal surgery.[9] In this trial of colorectal and liver resection patients, subjects were randomised into 2 groups: 69 had a CHO drink and 71 had a placebo. Outcome was assessed by fatigue, duration of hospital stay and discomfort along with biochemistry. Post-operative fatigue was similar between the groups while the hospital stay was shorter for the CHO group, with no adverse effects noted in either group.

Bisgaard *et al* evaluated the clinical effects of pre-operative CHO drinks in patients undergoing laparoscopic cholecystectomies.[10] A total of 94 patients were randomised to receive CHO drinks or a placebo. No cases of pulmonary aspiration were reported and scores of overall wellbeing, fatigue and appetite did not vary between groups, suggesting that pre-operative CHO drinks did not change clinical outcome following laparoscopic cholecystectomy. However, this cannot be directly applied to colorectal patients. Laparoscopic cholecystectomy is a minimally invasive intermediate surgical procedure with a rapid recovery. Direct comparisons cannot be made with major abdominal surgery as this is associated with a stress response, which may be altered by the use of CHO drinks. Nevertheless, it gives an insight into its potential application for patients undergoing laparoscopic colorectal resection.

Hausel *et al* investigated the effect of CHO on post-operative nausea and vomiting (PONV) following a laparoscopic cholecystectomy.[11] This RCT included all cholecystectomy patients over 20 months in 3 hospitals. This multi-centre nature may reduce consistency, validity and reliability. Exclusion criteria included delayed gastric emptying, difficult airway management, diabetes mellitus and ASA (American Society of Anesthesiologists) grade 3 or greater.

A total of 174 patients were recruited and randomised into 3 groups: the first group fasted from midnight, the second group received a placebo drink and the third group received a CHO drink. The latter two groups were blinded. In the first 24 hours, 23 of those who fasted, 23 of those in the placebo group and 15 of those in the CHO group had 1 or more episodes of PONV. PONV was only reduced significantly in the CHO and placebo groups. Nausea scores in the fasted ($p=0.018$) and placebo ($p<0.01$) groups were higher after surgery than before admission, with no increase observed in the CHO group ($p=0.082$). CHO drinks reduced PONV, both subjectively and objectively. Nevertheless, the study population was not representative of those patients who undergo colorectal surgery and so this would need further evaluation.

Metabolic implications

CHO drinks pre-empt catabolic responses to surgery. This is particularly important in diabetic patients, where perioperative glucose control is crucial to the outcome. Wang *et al* investigated the effect of CHO drinks on post-operative

Table 1 Summary of findings of reviewed randomised controlled trials

Reference	Aim of the study	Number of patients	Conclusion
Yulli *et al*[6]	Test patient tolerance of CHO and metabolic response	65	CHO is safe and well tolerated, with attenuated muscle depletion
Hendry *et al*[7]	Test patient compliance of CHO	99	CHO is well tolerated
Noblett *et al*[8]	Determine the effect of CHO on clinical outcome	36	Reduced hospital stay with hastened return of gastrointestinal function
Mathur *et al*[9]	Determine the effect of CHO on clinical outcome	140	Reduced hospital stay
Bisgaard *et al*[10]	Determine the effect of CHO on laparoscopic patients	94	Safe to give CHO
Hausel *et al*[11]	Assess the effect of CHO on PONV	174	CHO reduced PONV
Wang *et al*[12]	Determine the effect of CHO on postoperative insulin resistance	48	Improved metabolic profile in CHO patients
Svanfeldt *et al*[13]	Assess postoperative protein and glucose kinetics	12	Enhanced postoperative metabolic response
Svanfeldt *et al*[14]	Assess effect of CHO on insulin action	6	CHO enhanced insulin action
Gustaffson *et al*[15]	Determine safety of CHO in diabetic patients	35	CHO is safe in diabetics
Can *et al*[16]	Compare CHO in patients with or without insulin resistance	34	Similar pattern of response

CHO = carbohydrate; PONV = postoperative nausea and vomiting

insulin resistance (PIR) and whether altered insulin dependent activation of the PI3K/PKB signalling pathway would contribute to the development of PIR.[12] This RCT randomised 48 colorectal patients into pre-operative CHO, fasting or placebo groups. Subjective wellbeing was significantly better in the CHO and placebo groups compared with the fasting group. PIR was greater in fasting and placebo patients, and by the end of surgery muscle PTK activity as well as PI3K and PKB levels were significantly increased in the CHO group while GLUT4 expression was unaffected.

Svanfeldt *et al* explored the effect of CHO preparations on post-operative whole-body protein and glucose kinetics in colorectal surgery.[15] Over a 4-year period 663 patients were assessed for eligibility but only 12 were included. The patients received either a CHO drink of 125mg/ml or a CHO drink of 25mg/ml. Whole-body protein did not change in the high CHO group whereas it was more negative in the low CHO group after surgery at both baseline (p=0.003) and during insulin stimulation (p=0.005). Insulin stimulated endogenous glucose release was similar before and after surgery in the high CHO group but was higher after surgery in the low CHO group (p=0.013).

The same researchers conducted a further experimental trial. This evaluated the effect of CHO loading on insulin action at the time corresponding to the initiation of anaesthesia and surgery in a pre-operative simulated setting on six healthy individuals.[14] Participants were randomised into four separate groups: CC (in which no drink was given), LC (in which the subjects had an 800ml CHO drink the night before), CL (in which the subjects had a 400ml drink on the morning before the intervention) and LL (in which subjects had the 800ml and 400ml drink as described).

After 120 minutes an insulin infusion was commenced with regular blood glucose monitoring. Normoglycaemia was achieved by a variable infusion of glucose to achieve a glucose level of 4.5mmol/l. Indirect calorimetry was performed at 30 minutes on 4 occasions. This study demonstrated that CHO-rich drink enhances insulin action three hours later by 50%. However, the subjects' healthy state and the fact that it was an artificial study reduces clinical applicability.

In 2008 Gustaffson *et al* considered the suitability for diabetic patients to have CHO drinks pre-operatively.[15] Ten healthy controls and twenty-five type 2 diabetic patients were recruited to investigate the hypothesis that this strategy was not safe due to delayed gastric emptying in diabetes. A 400ml 12.5% CHO drink was given with 1.5g paracetamol. Surprisingly, patients with neuropathy were excluded as autonomic neuropathy is a likely cause of delayed gastric function in diabetes. No difference in gastric emptying rate existed between the two groups. In diabetics the baseline serum glucose was higher while the concentration rose

more slowly and peaked higher at a later time. The return to baseline occurred at 120 and 180 minutes in the healthy and diabetic state respectively. This suggests there is no reason not to give diabetic patients CHO pre-operative drinks. However, the wider spectrum of diabetic patients was not evaluated.

More recently, Can *et al* evaluated the effects of pre-operative CHO loading in patients with or without insulin resistance. This differed from other studies, which had previously excluded those with known insulin resistance.[16] This was a non-randomised, blinded cohort study performed over 16 months and it included 34 cholecystectomy or thyroidectomy patients. All patients were given 800ml of CHO drink on the evening before surgery and 400ml 2–3 hours before surgery. Plasma glucose, cortisol and serum insulin were taken immediately before the morning dose, at 40 minutes, at 90 minutes and at induction of anaesthesia.

Of the 34 patients, 8 were found to have insulin resistance. The temporal pattern of plasma glucose in patients with insulin resistance who were given CHO drinks pre-operatively was similar to that of patients without insulin resistance. A major limitation of this study is the lack of post-operative analysis. Furthermore, elective colorectal patients were not included.

Conclusions

Within the setting of colorectal surgery, CHO supplements are safe. A summary of the main findings of each of the RCTs is given in Table 1. Pre-operative CHO drinks do not alter pH or the volume of gastric contents and there is no increased risk of aspiration or any other associated complications. Level 1 evidence shows CHO drinks pre-operatively result in a shorter hospital stay, a quicker return to bowel function, a decrease in the loss of muscle mass and a reduction in PONV. Physiologically, CHO-rich drinks enhance insulin action and patients with insulin resistance, when given CHO drinks, have a similar plasma glucose pattern.

The heterogeneity of study aims, as summarised in Table 1, precludes a meta-analysis being performed meaningfully at present. However, as evidence continues to accumulate in favour of the use of pre-operative CHO supplementation, this would seem to be the next sensible step to enhance the body of available evidence so that it could be consolidated and assimilated into routine clinical practice.

On the basis of the evidence reviewed here, the use of pre-operative CHO drinks should be standard in elective colorectal patients. However, further research is required for diabetic patients.

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